Ulnar length – A Tool for Stature Estimation

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Abstract

Stature is a important factor in identification of an unidentified dead body or any mutilated part of such body. In present study we made an attempt to estimate the stature from percutaneous length of ulna. Study consists of 94 adult males and 96 adult females between the age group of 18- 24 years, born and brought up in Maharashtra. The length of the of the right and left ulna was measured with a venier calliper from the apex of the olecranon to the styloid process and the height of the individual was measured with a calibrated standing meter rule. The measurements were noted in the proforma. The data was statistically analyzed and linear regression formulae were derived.

***Key Words**: Ulnar length, Stature, Linear regression*.

Introduction

Stature is a important factor in identification of an unidentified dead body or any mutilated part of such body.[1] Anthropometry has an extensive application in forensic sciences, and it is receiving augmented use especially in the discipline of Forensic Medicine and Anatomy. Anthropometric data are believed to be objective. [2]

When intact bodies are to be examined, stature estimation does not pose any problem. However, in cases of dismembered human body parts, mutilated and decomposed bodies there is a greater challenge for the forensic experts. Several factors are taken into consideration for establishing the identity in these cases. Stature is considered as one of the important parameters for personal identification and stature reconstruction plays a vital role in identification of individuals.[3] Assessment of height from different parts of body by anthropometry of skeleton is always an area of interest to anatomist, anthropologists and forensic experts.[4]

In calculating stature from bones, regression formulae based on long-bone measurements is the easiest and trustworthy method that yields the most accurate results. The ulna is a long bone that is often used for body height estimation. Once the ossification of all bones is complete, there is no further growth of a person. Ossification of upper limb bones is usually complete within 19-22 years of age. Hence, the present study was conducted on persons belonging to age group of 19 -24 years with an effort to establish a correlation between length of ulna and body stature. [2]

The equations that were derived by Trotter and Gleser in the early 1950s for Americans were being continuously revised using data from different sources. In 1961, Allbrook attempted to develop standards for the estimation of stature from a British sample using ulnar length.[5] The most detailed description of stature estimation from skeletal remains was compiled by Krogman and Iscan. Pearson estimated the stature from long bones by formulating the regression equations. He also found that these formulae are population specific and should not be applied to individuals of different population groups. [6].

Material and Method

The present study comprised of a total 190 Medical college students belonging to different regions of Maharashtra residing in and around Jalgaon. Their age ranged between 19 to 24 years. After obtaining informed consent from the study participants we recorded the data in our proforma. Students with

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significant systemic diseases, history of old fractures, orthopaedic malformation, developmental disorders, metabolic disorders which could have affected the bony growth were excluded from study. The measurements were taken at a fixed time of a day to eliminate diurnal discrepancy. Ulna is mostly subcutaneous throughout its length and easily approachable for measurement.

The length of the of the right and left ulna was measured with a standard venier calliper from the apex of the olecranon to the styloid process with the elbow in full flexion and the height of the individual was measured from crown to heel with head oriented in Frankfurt's plane with a calibrated standing meter rule.

The measurements were tabulated in the proforma and the data was analyzed using SPSS version 24 statistical package. The linear regression formulae were also derived to determine the stature separately for males and females.

Observation & Results

Table 1: Mean, SD and Range for all the parameters (Males)

Parameter(cm)	Mean	SD	Range
Height	175.58	5.17	169-185
Length of Ulna(right)	28.54	0.93	27.20-30.50
Length of Ulna(left)	28.82	0.91	27.60-30.80

Mean height was 175.58±5.17 cm, mean length of right ulna was 28.54±0.93 and mean length of left ulna was 28.82±0.91 in males.

Table 2: Mean, SD and Range for all the parameters (Females)

Parameter(cm)	**Mean**	**SD**	**Range**
Height	158.94	4.35	148-167
Length of Ulna(right)	25.81	1.07	23.80-27.30
Length of Ulna(left)	25.58	1.09	23.50-27.10

Mean height was 158.94±4.35cm, mean length of right ulna was 25.81±1.07 and mean length of left ulna was 25.58±1.09.

Table 3: Comparison of length of right and left ulna

	Length of ulna (Right)	**Length of ulna (Left)**	**z-value**	**p-value**
Male	28.54±0.93	28.82±0.91	2.10	0.36, NS
Female	25.84±1.07	25.58±1.09	1.64	0.10,NS

Mean length of right ulna for males was 28.54±0.93 and for left ulna it was 28.82±0.91 cm and mean length of right ulna for females was 25.84±1.07 cm and for left ulna it was 25.47±1.09 cm. By using z-test for difference between two means, statistically insignificant difference was found in mean length of right and left ulna in males and females also.

Table 4: Pearson's Correlation Coefficient

Subjects	Correlation Coefficient (r)	Coefficient of Determination (%)	p-value
Male	0.866	74	0.0001,S
Female	0.918	84	0.0001,S

Above table shows that the correlation of height with length of ulna is 0.866 in males and 0.918 in females, which are positive and statistically highly significant ($p<0.01$) i.e. if length of ulna increases, the height of the subject also increases and vice versa.

Table 5: Pearson's Correlation Coefficient

Subjects	Correlation Coefficient(r)	Regression Equation	p-value
Male	0.866	Y =36.12 +4.86 X	0.0001,S
Female	0.918	Y =16.98 + 5.52 X	0.0001,S

Above table shows the linear regression equation for height with length of ulna in male and female where,

Y = Height/ Stature (cm) and X = Length of ulna (cm)

36.12 and 16.98 are intercept (constant) for male and female respectively.

4.86 and 5.52 are regression coefficient for male and female respectively.

Here it is observed that the regression formula within a region also varies between male and female population of that region.

Table 6: Pearson's Correlation Coefficient

Subjects	Correlation Coefficient(r)	Regression Equation	p-value
Male			
Right Ulna	0.875	Y = 36.54 + 4.87 X	0.0001,S
Left Ulna	0.854	Y= 36.73 + 4.81 X	0.0001,S
Female			
Right Ulna	0.919	Y =14.84 + 5.57 X	0.0001,S
Left Ulna	0.917	Y = 20.45 + 5.41 X	0.0001,S

Above table shows the linear regression equation for height with length of ulna in male and female where,

Y = Height/ Stature (cm)

X = Length of ulna (cm)

36.54, 36.73 are intercept t(constant) of right and left ulna of male.

14.84, 20.45 are intercept (constant) of right and left ulna of female.

4.87, 4.81 are regression coefficient for male,

5.57, 5.41 are regression coefficient for females.

Discussion

Anthropometry is considered as the simple, inexpensive, non-invasive method to assess body proportions. Stature estimation methods cannot be universally applied due to the influence of environment among population, modernisation and social economic development between nations and even among people of the same nation. [7]

In our study, correlation coefficient (r) of height and length of right ulna is 0.875 and of left ulna is 0.854 in males; 0.919 (right ulna) and 0.917 (left ulna) in females. In the study by Amit Mehta et al, the correlation coefficient (r) of height and length of right ulna is 0.754 and of left ulna is 0.70. (1). In study by Anupriya & Kalpana, the correlation coefficient (r) was 0.754 (right ulna) and 0.745 (left ulna) in males; 0.691 (right ulna) and 0.701 (left ulna) in females.[8] The value of r shows a positive correlation which is also very highly significant ($P < 0.001$). The Correlation coefficient between the total height and length of ulna was found to be positive indicating a strong relationship between the two parameters. The positive correlation suggests if length of ulna increases or decreases, the height of the subject also increases or decreases and vice versa.[6] It must be noted that estimates are mean values with appropriate standard deviations, so estimated stature of unidentified remains may be inaccurate by several centimeters.[9] The data of the study can be used for estimation of stature amongst specific ethnic group.

Various authors have shown a significant correlation between height and length of ulna. Allbrook derived regression formulae for estimation of stature from the length of ulna in British population as: Stature: 88.94 + 3.06 (ulnar length) ± 4.4 (Standard error). Athawala derived a regression formula for estimation of stature in Maharastrians of India; Stature = 56.9709 cm + 3.9613 X average length of right or left ulna (cm) ± 3.64 cm. In our study the linear regression equation for males is stature= 36.12+ 4.86 x length of ulna and for females, stature= 16.98 + 5.52 x length of ulna. [2]

In study by Babu RS et al, mean value of right ulnar length is 27.84 cm and that of left ulnar length is 27.75 in males.[3] According to Borhani-Haghighi M. et al, the mean length of the ulna was 29.17 cm in males and 26.47 cm in females. In our study, mean length of right ulna was 28.54±0.93 and mean length of left ulna was 28.82±0.91 for males. For females mean length of right ulna was 25.81±1.07 and mean length of left ulna was 25.58±1.09. Similar were the observations by Bamne et al and Ashish Pande. [5, 6, 10, 11] In the study by Anjali Prasad et al, gender differences in mean height and length of ulna were found to be highly significant and mean ulna lengths of the male were significantly larger than that of the females of all ages. The mean value of length of right and left ulna is statistically insignificant in males and also in females correlating with our study. [12]

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References

1. Amit A. Mehta, Anjulika A. Mehta, V.M. Gajbhiye, Sarthak. Verma. Estimation of stature from ulna. Int J Anat Res 2015; Vol 3(2): 1156-58.
2. Subodh Kumar Yadav, Birendra Kumar Mandal, Abhishek Karn. Determination of stature from ulnar length in Nepalese population. European Journal of Forensic Sciences. 2015 ; Vol 2 (1): 5-8.
3. Rameswarapu Suman Babu. Estimation of Body Stature Using Fore Arm Bone (ULNA) – A Cross Sectional Study. J of medical Sc. and clinical Research. 2015; 3(8): 7199- 7202.
4. Maloy Kumar Mondal, Tapan Kumar Jana, Jonaki Das, Sumohan Biswas. Use of ulna for estimation of stature in living adult male in Burdwan district and adjacent areas of West Bengal. J. Anat. Soc. India. 2009; 58(1): 16-18.

5. Bamne et al. Estimation of stature from ulnar length in Maharashtrian population. Inter. J.l of Medical Science and Public Health. 2015; Vol 4 (1): 65- 69.
6. Ashish Pandey, Radhika P.M, Shailaja Shetty. Estimation of human stature from length of ulna in indian population. Int. J. Anat Res. 2017; 5(1): 3350-53.
7. Acharya Veena Anand et al. Stature estimation measuring percutaneous length of ulna in living subjects. Indian Journal of Clinical Anatomy and Physiology. July-September 2016; 3(3): 270-275.
8. Anupriya and Kalpana. Estimating the Height of an Individual from the Length of Ulna in Tamil Nadu Population and its Clinical Significance. International Journal of Scientific Study. April 2016; 4(1): 254-257.
9. L Ebite, T Ozoko, A Eweka, P Otuaga, A Oni, F Om'Iniabohs. Height: Ulna Ratio: A Method of Stature Estimation In A Rural Community in Edo State, Nigeria. The Internet Journal of Forensic Science. 2008; Volume 3 Number 1: 1-4.
10. Borhani-Haghighi M. et al. Height prediction from ulnar length in Chabahar: a City in South-East of Iran. Romanian Journal of Legal Medicine. 2016; 24(4): 304-307.
11. Anupam K. Bansal et al. A Study of relation between stature and ulnar length. Int J Res Med. 2014; 3(4): 137-139.
12. Anjali Prasad, V B Bhagwat, Satish Porwal, D S Joshi. Estimation of Human Stature from length of ulna in Marathwada Region of Maharashtra. International Journal of Biological & Medical Research. Int J Biol Med Res. 2012; 3(4): 2337-2341.